DISCRETE SINGULAR CONVOLUTION FOR THE PREDICTION OF HIGH FREQUNCEY VIBRATION OF PLATES

G. W. Wei[a] , **Y. B. Zhao**[b] and **Y. Xiang**[c]
[a]Department of Mathematics, Michigan State University, East Lansing, Michigan 48824,
wei@math.msu.edu
[b]Department of Computational Science, National University of Singapore, Singapore 117543
[c]School of Engineering and Industrial Design, University of Western Sydney, Penrith South
DC NSW 1797, Australia

Theoretical analysis of high frequency vibrations is indispensable in a variety of engineering designs. Despite of much effort in the past few decades, the numerical prediction of high frequency vibrations remains a challenging task to the engineering and scientific communities due to the numerical instability of existing computational methods. However, such prediction is of crucial importance to certain problems of pressing practical concern, such as aerospace structures, potential high frequency weapon systems, as pointed out by Langley and Bardell (The Aeronautical Journal, 102, 287-297, 1998). This paper introduces a novel computational approach, the discrete singular convolution (DSC) algorithm [1-5] for high frequency vibration analysis of beams, plates and two-span plates. Square plates with six distinct boundary conditions are considered [6,7]. To validate the proposed method, a completely independent approach, the Levy method, is employed to provide closed-form solutions for a comparison. The proposed method is also validated by convergence studies. Remarkably, extremely accurate and stable results are obtained in this work, e.g., the relative DSC errors for the first 7100 modes of the beam, the first 5000 modes for plates and the first 4500 modes of the two-span plates are all less than 1%. No numerical instability is encountered in the present study.

References

[1] G.W. Wei, ``A new algorithm for solving some mechanics problems,'' *Computer methods for Applied Mechanics and Engineering*, v. 190, p. 2017-2030, 2001.
[2] G.W. Wei, ``Vibration analysis by discrete singular convolution,'' *Journal of Sound and Vibration*, v. 244, p. 535-553, 2001.
[3] G.W. Wei, ``Discrete singular convolution for beam analysis,'' *Engineering Structures*, v. 23, p. 1045-1053, 2001.
[4] G.W. Wei, Y.B. Zhao, and Y. Xiang, "Analysis of Rectangular Plates with Mixed Boundary Conditions by Discrete Singular Convolution," *International Journal of Mechanical Sciences*, v. 43, p. 1731-1746, 2001.
[5] G.W. Wei, Y.B. Zhao, and Y. Xiang, "Discrete singular convolution and its application to the analysis of plates with internal supports. I. Theory and algorithm," *International Journal for Numerical Methods in Engineering*, v. 55, p. 913-946, 2002.
[6] G.W. Wei, Y.B. Zhao, and Y. Xiang, "A novel approach for the analysis of high frequency vibrations," *Journal of Sound and Vibration*, v. 257, p. 207-246, 2002.
[7] Y.B. Zhao G.W. Wei, and Y. Xiang , "Discrete singular convolution for the prediction of high frequency vibration of plate," *International Journal of Solids and Structures*, v. 39, p. 65-88, 2002.